

# Public Safety Workbook

## Ammonia Safety Day Coalition

### THE TRIPOD

INDUSTRY, GOVERNMENT, AND PUBLIC SAFETY

#### INDUSTRIAL COMMAND

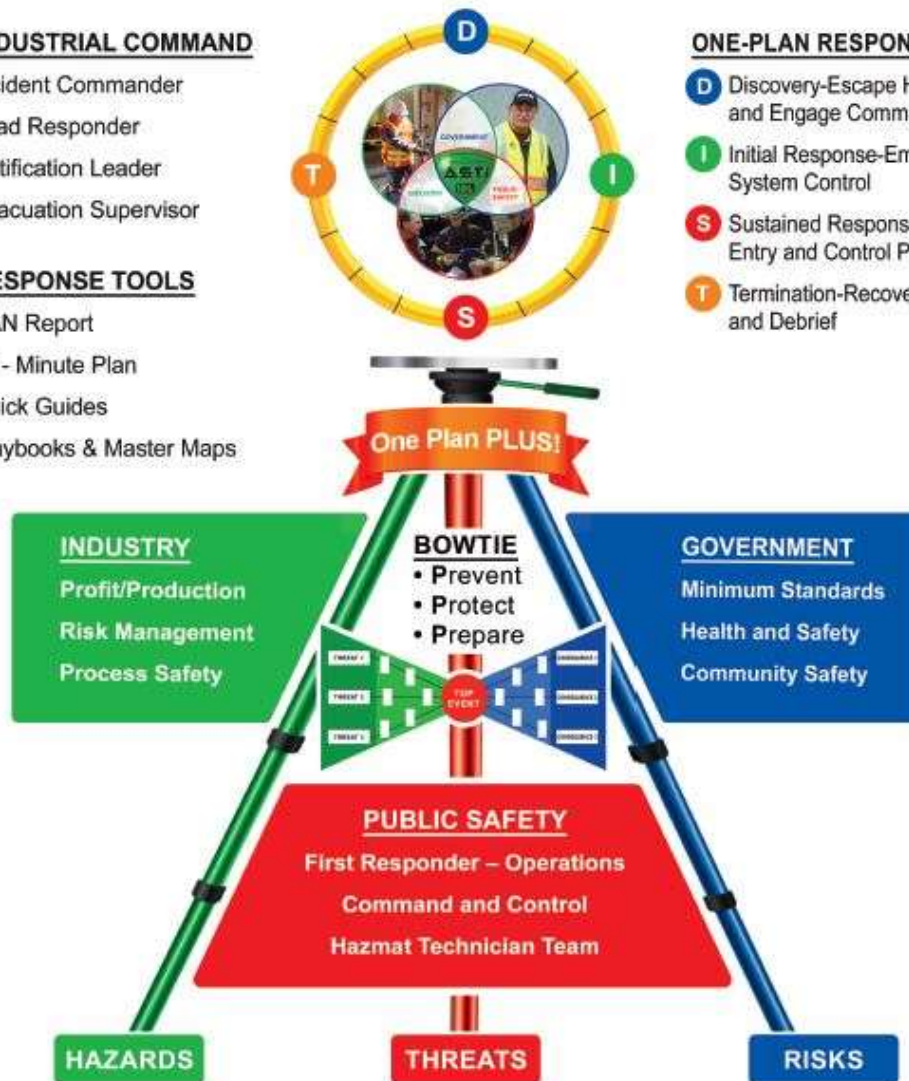
Incident Commander  
Lead Responder  
Notification Leader  
Evacuation Supervisor

#### RESPONSE TOOLS

CAN Report  
30 - Minute Plan  
Quick Guides  
Playbooks & Master Maps

#### ONE-PLAN RESPONSE

- D** Discovery-Escape Harm and Engage Command
- I** Initial Response-Emergency System Control
- S** Sustained Response-Entry and Control Plan
- T** Termination-Recover and Debrief



TRIPOD TEAMS ENSURE GOOD THINGS OCCUR  
IF BAD THINGS HAPPEN



Prevent Them All or Stop Them Small™

*Hazards, Risks, and Threats (HRTs) Defined*

## 1. Introduction of Hazards

**Hazards:** Chemical and physical characteristics associated with the chemical or specific conditions that may harm an employee while working in or near a dangerous area.

- Hazards are defined during a Process Hazard Analysis, hazardous materials inventory, pre-entry hazard analysis, and/or during fire and life safety inspections.

**Risks:** Hazards become risks when they are identified by emergency planners as threats to life safety, environment, and/or property.

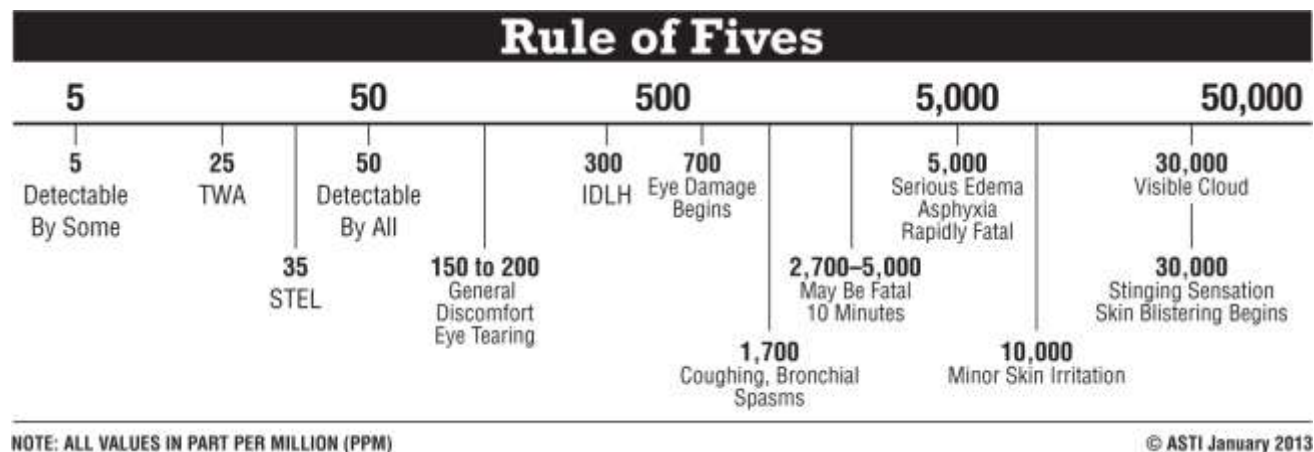
- Risks are prevented, mitigated, and prepared (PMP) to reduce the threat to life safety, environment, and/or property. Emergency planners address risk by complying with regulatory requirements and engaging safe work practices.

Ammonia 7664-41-7 (Final) - Expressed in PPM					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	30	30	30	30	30
AEGL 2	220	220	160	110	110
AEGL 3	2,700	1,600	1,100	550	390

**AEGL-1** is the airborne concentration above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

**AEGL-2** is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

**AEGL-3** is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.



**Threats:** Hazards and risks materialize into threats as workers and emergency responders approach a danger zone. Threats include fire, explosion, structural collapse, electrical arc flash, and chemical release.

- Workers and emergency responders are prepared to recognize and protect themselves from the hazards and risks. They wear personal protective equipment, engage SOPs, and take actions to prevent and/or mitigate the threats before exposure to those threats is dangerous to life and health.

### ***Prevent-Mitigate-Prepare for the HRTs***

**Prevention:** Housekeeping, storage practices, clearly marked exits, RAGAGEP (Recognized and Generally Accepted Good Engineering Practices) maintenance, operations, and service practices.

**Mitigation:** Good Engineering Practices used to reduce the potential impact of the HRT concerns, e.g., safety barriers, early warning systems, fire sprinkler systems, automated control systems, isolation valves, and built in options to reduce pressure, isolate a release, mitigate the fire threat, and ventilate dangerous environments.

**Preparedness:** System operators, supervisors, emergency responders and all workers who may be impacted by HRTs must be trained and equipped with an appropriate personal protective equipment (PPE) ensemble that matches their level of HRT exposure.

### ***Hazard Zone Readiness***

Every industrial plant has locations where the HRTs offer special HRT concerns. For example a cold storage plant might identify Hazard Zones for the mechanical room, roof-top condensers, and cold rooms. The battery recharge room and chemical storage room might also be setup as Hazard Zones.

Why define a Hazard Zone? Each Hazard Zone has a defined list of HRT concerns that can be prevented, mitigated, and prepared for. Hazard Zones that pose the highest level of HRT concern will receive the highest level of PMP activity. The emergency planning team will address the PMP concerns that are most likely to occur, especially if they link to other HRT concerns that may domino into major emergency or catastrophic concern.

### ***Root Causes for Process Safety Incidents***

The root causes for process safety incidents (loss of containment events), are deficiencies in process safety management practices.

Over the last 50+ years across many industry sectors and in companies of all sizes, time and time again the same types of issues have been found to be causes for serious loss of containment events involving a wide range of highly hazardous materials, including ammonia.

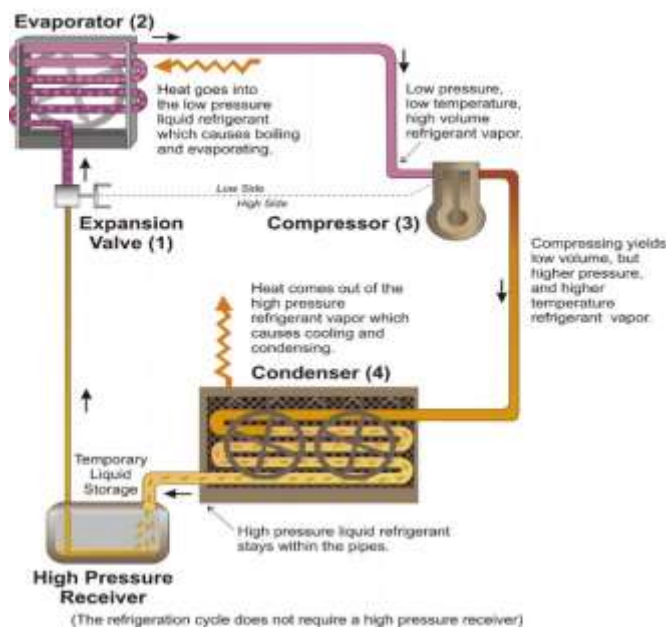
These issues are listed in the figure on the next page. They are related to a number of management system issues including safety culture of the organizations.

Also shown is a list of six additional management system elements for risk based process safety (as defined by the American Institute of Chemical Engineers Center for Chemical Process Safety (AIChE CCPS)). These management system elements are not currently included in OSHA PSM compliance requirements but should be addressed by organizations in order to eliminate many of these recurring causal factors.

## 2. Refrigeration and Pressure Vessel Challenges

### Refrigeration Cycle Shown Graphically

The four components of the refrigeration cycle



### EMERGENCY SHUTDOWN

#### SOURCES OF IGNITION: DEFENSIVE HAZARD ROOM CONTROLS

Concern for flammability at 20,000 PPM (15,000 PPM within a room or confined area); high threat for visible dense gas cloud (very cold atmosphere).

1. **Turn on emergency fans.** Consider use of positive pressure portable fans if built-in ventilation is not adequate.
2. **Shutdown of Sources of Ignition.**
3. **Maintain ventilation air intake** return vent air for mechanical ventilation.
4. **Evaluate the downwind** receptor concerns for exhaust venting from positive pressure ventilation.

Consider a 500' to 1,000' Isolation Zone when venting a dense gas cloud.

#### ISOLATE AND/OR TRANSFER LIQUID: DEFENSIVE HAZARD ROOM CONTROLS

Locate the release point: Reduce or re-direct the liquid feeding the release. Cover and contain the release if safe to do so.

1. **Isolate upstream valve(s).** Consider closing the King Valve, if necessary, to stop downstream liquid flow (avoid trapping liquid).
2. **Transfer or pump** the low-side liquid to a safe location (may require new heat or pressure to move the liquid). Move as much liquid as possible to the low-side before shutting down compressors. Move high-side liquid to a safe location. Consider moving the liquid to the low-side.

#### PRESSURE MANAGEMENT

**Objective:** Pressure management. Reduce high-side pressure by moving stored energy away from the problem area. For low-side, stop sending new energy out to the problem area.

**CAUTION:** Prevent hydraulic liquid/vapor shock when closing valves.

- Do a process hazard analysis (PHA) to evaluate high-and low-side pressure management.
- Avoid fast actions such as terminating a hot gas defrost cycle and causing a sudden surge or shock.

### ***3. Preparedness for Working inside and outside of the “Danger Area”***

**Isolation Zone:** The Isolation Zone requires a perimeter at the AEGL-2 level of exposure. Emergency responders should not be allowed to enter the Isolation Zone without proper PPE.

**Danger Area:** The Danger Area contains hazards, risks, and threats that the trained Operator must consider when deciding to perform incidental control. The Operator must assure the safety of those who may be exposed to the dangerous circumstance BEFORE considering incidental control and/or emergency shutdown. The circumstances that create a Danger Area are above the normal service and maintenance threats. An emergency would be proclaimed and an Isolation Zone would be set for chemical exposure, arc flash, overpressure, fire threat, or other dangerous circumstances that may threaten the health and safety of the responder and/or any people within the Danger Area. Imminent danger exists when exposure limits threaten to exceed the limits of the Operator’s personal protective equipment and the Operator’s ability to assess the hazards, risks, and threats of the potential emergency event.

**Incidental Response:** Actions are defined within an employer-developed Standard Operational Guideline (SOG). Trained and equipped operators will work in a non-dangerous circumstance to immediately contain and/or control a hazardous circumstance that could become an emergency event. The incidental response requires training, PPE, and ability to judge hazards, risks, and threats.

**Emergency Shutdown** is performed in accordance with 29 CFR 1910.38 for non-engagement emergency response and 29 CFR 1910.120 for responder engagement to contain and control an emergency event while working in the danger area. Facilities are required to prepare written emergency shutdown procedures and instructions for use by operators, emergency responders, and others. At a minimum, these materials should be developed for each of the most likely emergency scenarios. These materials should include a manual of operating instructions, a system drawing showing the integral parts of the emergency shutdown procedure (Green Playbook) and their locations at the facility, the procedure to shut down the refrigeration unit for an extended period of time, emergency shutdown procedures and subsequent start-up procedures, a table of the ranges of safe operating parameters measured at crucial meter locations, safety procedures to be exercised at various locations, and locations for recharging the system as well as the specifications of the charge materials.

**Incidental and Emergency Shutdown Personal Protective Equipment (PPE):** The most important part of the “stop them small” approach is to assure that the trained operator is prepared to stop the problem while wearing appropriate PPE. It all starts with Pre-Emergency Readiness and a level of SOP discipline to engage Command Team readiness as well as the appropriate PPE. The following are the PPE recommendations that will be considered for the final draft of the Best Management Practices (NOT currently available for use – please stay with current code until the BMP becomes a RAGAGEP). The PPE must be aligned with the Plant emergency shutdown and incidental control SOP. The exposure time for engaging the SOP should be no more than 10 minutes (designed for incidental and emergency shutdown operations NOT for emergency response plan engagement):



## 4. Safety, Health, and Injury Readiness

1. PPE for up to 700 PPM (current code is 300 ppm) of ammonia vapor for less than 10 minutes of exposure time – working outside of visible clouds and/or ammonia liquid:
  - **Eye and Respiratory Protection with an Ammonia Monitor:** Air Purifying Respirator, full-face respirator (APR) or Powered Air Purifying Respirator (PAPR) for up to 700 PPM.
  - **Skin and Flash Protection:** Nomex hood, gloves, flame-resistant overalls, cotton underclothing, safety boots.
  - **Hazard Assessment:** Electrical hazards or flash fire concerns require arc-flash protection.
2. PPE for up to 10,000 PPM (current code limits Level B at 5,000 ppm) of ammonia vapor for less than 10 minutes exposure time:
  - **Eye and Respiratory Protection with an Ammonia Monitor:** Self-Contained Breathing Apparatus for up to 10,000 PPM for 10 minutes of exposure
  - **Skin and Flash Protection:** Nomex hood, gloves, flame resistant overalls, cotton underclothing, safety boots (chemical resistant and insulated if working in and around ammonia liquid) for response to up to 5,000 PPM; Level B ensemble to protect against 10,000 PPM of ammonia vapor.
  - **Hazard Assessment:** Electrical hazards or flash fire concerns require arc-flash protection.

There are **two Initial Response objectives** for engaging life safety and emergency shutdown.

**Minimize the time it takes** for the Lead Responder **to evaluate the Isolation Zone** and discover the need for **rescue, decon, and medical care**.

**Minimize the time** it takes to **discover the source of the problem and then engage the Plant policy** for accomplishing **Hazard Zone emergency shutdown**.

The key difference between **Initial Response** (emergency shutdown) and **Sustained Response** (entry into the danger area) relates to the response team's ability to **address the hazards, risks, and threats**. Initial response is engaged while **working outside of the danger area**. **Sustained response** involves Technician trained responders to judge hazards, risks, and threats **before** entry into the **danger area to contain and control an emergency event**.

**Scenario Based Training:** Demonstration of each phase of response utilizing the Tripod Team. Each of the simulations would start with a Hazard Analysis and end with a review of regulatory concerns.

- **Pre-emergency readiness:** Utilize the ASTI response gear and the ASTI SOP for Pre-Emergency Readiness on a simulated repair.
- **Evacuation, Emergency Medical, Decon:** Review of the emergency response readiness for moving victims out of the danger area to decon and then to the medical treatment area.
- **CAN Report:** Use of the CAN report for information exchange between plant response team members and with the Public Safety first responders.
- **Rescue Technique:** Demonstrating the size-up and set-up for doing rapid entry rescue. Highlight the value of early callout of 9-1-1 and immediate integration with the Command Team for a synchronized rescue plan.

- **Emergency Shutdown:** Discussion and review of a Green Playbook description of emergency shutdown for the mechanical room hazard zone. The back-up from the fire department first-responders would be included in the discussion.

## HAZARD ANALYSIS QUICK GUIDE

### Hazard Analysis: Health, Fire, Pressure, Instability, and Corrosiveness



#### Level of Concern: Trigger Points for Engagement

- 1 = Controlled and Contained: INCIDENTAL; optional 9-1-1
- 2 = Controlled or Contained: EVACUATE ISOLATION ZONE; 9-1-1 and Regulatory
- 3 = Uncontrolled and Uncontained, or High Life Threat: EMERGENCY; 9-1-1 and Regulatory

#### Life Safety: Isolation Zone (IZ), and Protective Action Distance (PAD)—AMMONIA

Small Release = 100 ft. PAD: 550 ft. or 0.1 mile  
 Large Release = 500 ft. PAD: Day = 0.5 miles; Night = 1.3  
 miles Catastrophic Release = 1,000 ft. PAD: Track plume beyond 1.3  
 miles

Note: distances are  
estimates for the first  
30 minutes

**Wind Movement:** Eye-level wind indicators for ground level wind, and wind sock for roof top wind direction. Caution for wind eddies and wind turbulence due to building wind deflection.

**Escape:** Laterally and upwind or shelter-in-place

Ammonia 7664-41-7 (Final) Expressed in PPM					
Acute Exposure Guideline Level	10 min	30 min	60 min	4 hour	8 hour
AEGL 1	30	30	30	30	30
AEGL 2	220	220	160	110	110
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865-1 Ammonia Vapor Expansion Ratio @70°F 1300-1 Absorption Ratio of Ammonia Vapor to Water

**Check nearest shower, eye-wash, decon stations** (primary and secondary locations)

**Medical Treatment Plan:** Worried/well, Walking/wounded, Acute Health Concern (See pp. 9-10)

#### Personal Protective Equipment and Monitoring Control Zones and Entry

NO entry into IDLH (300 PPM) without IC approval and back-up

Medical treatment plan for worried well, walking wounded, and acute health concerns

Vapor Protection: Level B < 5,000 PPM and Level A > 5,000 PPM

Flammability = No entry > 15,000 PPM without mitigations and flash protection

Aerosol Stream/Dense Gas: Level A with flash-fire and cold temperature protection (especially gloves/boots)

Chemical Monitoring (fixed and/or handheld): Control Zones and Entry Team

## FIRST AID AND DECONTAMINATION

This First Aid page is supported by Medical Triage on page 9.

**Inhalation** – Fresh air and/or medic-administered oxygen – “rattling” lung sounds require medical follow up; symptoms should begin to develop within 3 to 5 minutes after escape; in many cases the odor and throat/nose irritation will linger 2 to 24 hours. Vapor exposure decon can be accomplished with an exhaust fan. (See pp. 6–7)

**Ingested  $\text{NH}_3$**  – Maintain airway, no vomiting, small amount of water if conscious and alert, seek medical care immediately.

**Skin Burns** – Vapor concentrations can cause skin irritation; skin burns are likely when directly exposed to 10,000 to 30,000 PPM vapor, to liquid, or aerosol exposure.

**Decon** – Use high-pressure fan for vapor decontamination and water for eye injury, skin redness, or burns. Decon hose line with high volume/low pressure nozzle is recommended to augment shower and eye wash.

Remove clothing (including shoes and socks) immediately unless frozen to skin; use water (**tepid 60°F to 100°F**) to flush and thoroughly rinse burn area (skin and/or eyes) for at least 15 minutes (redness) and 30 minutes (blistering). Contaminated clothing will cause skin burns.

**Eyes** – Wear eye protection because an aerosol droplet may enter the eye and cause blindness. Vapor exposure will cause eye damage at >700 PPM. Avoid wearing contact lenses when in an atmosphere  $\text{NH}_3$ .

**Heart** – Call 9-1-1 to summon professional medical response. If cardiac arrest occurs (no pulse) start chest compressions, (about one per second) two fingers up from bottom of the sternum. Keep doing chest compressions until relieved by a trained medical responder.

**Heat** – Lay or sit the victim down in a cool place, cool neck, armpits, and groin with a wet towel(s); monitor blood pressure; give water to drink if the victim is conscious and alert. Seek advanced medical care if the victim is not responsive and/or showing signs of shock.





## SAFETY OFFICER CHECKLIST

**Radio communications:** Consider frequencies for command, operations, and evacuation.

**Rapid entry rescue** can be accomplished with SCBA respiratory protection and Level C PPE if ammonia vapor does not exceed 5,000 PPM.

**Ensure clear access to exits:** Have an escape plan, engage Emergency Shutdown, backup support, emergency decon and medical support, and exhaust fan to support the trapped victim and Entry Team.

**Ensure emergency alert procedures are understood** prior to sending Response Team members into the danger area. (**See back of 30-Minute Plan and pg. 36**).

**Personnel accountability:** PPE readiness, zones and controls, ammonia monitoring, and eye-level wind indicators.

**Monitor Entry Team** on-air time(s) and assure back-up team readiness.

**Decon and rehab readiness:** Fans for vapor exposure or water for skin/eye burns; rehab to include hydration, cardiac check, and rest period.

**Lay a fire hose line** for safety and decon; identify alternate shower/eye wash

**Ensure lock-out/tag-out**, confined space, and placard warnings.

**Watch out for wind shifts**, wind turbulence (around buildings and alleyways); set up eye-level wind indicators to determine the movement of ammonia vapor.

Always use the **buddy system** and an IAP and Safety Plan BEFORE entering the HOT ZONE to contain and/or control release.

Only turn a valve when you **understand the consequences** on the upstream and downstream of opening or closing the valve.

**Never make fast moves** when operating an ammonia system.

**Never use excessive force**, especially leverage-supported wrench pressure on a tightly closed valve.

**Never change the Action Plan task assignments** without IC approval.

**PPE ensemble considerations:** SCBA, total skin coverage (Level A, B, or C), chemical monitor, exhaust fan, radio frequency, tagline, hand tools, eye-level wind indicator, and rescue and decon kits.

**Public Safety First Responders:** What do you expect from the Industrial Command Team when you arrive at an ammonia emergency?

**Is your team** aware of how to set the Isolation distance when focusing on emergency operations in a danger area where ammonia is being released from an unknown cause?

**The Plant IC has requested** your support to “back-up” the Operations team as it engages emergency shutdown. Are you ready for that?

**During the accountability check** the Evacuation Group Supervisor finds that an electrician is missing. He was working in the electrical control room located adjacent to the refrigeration mechanical room. The level of ammonia is 4,000 PPM. What’s your plan?

**There are four injuries**, one ammonia burn, one with eye exposure of 1500 PPM, and two who breathed about 400 PPM for five minutes. What’s your plan for decon, medical treatment and transport?

**How long** will it take to implement your plan?

**The ammonia cloud** is drifting off site. What’s your plan?

**How valuable is a CAN report** for the transition of command from one IC to another?

#### **CAN REPORT**

**Conditions:** What's happening now?

Type of Event? \_\_\_\_\_

Controlled or Contained? \_\_\_\_\_

Chemical PPM? \_\_\_\_\_

Fire Threat? \_\_\_\_\_

Level of concern 1, 2, or 3? \_\_\_\_\_

Isolation distance (100' to 1000'): \_\_\_\_\_

Wind Direction: \_\_\_\_\_

Other: \_\_\_\_\_

**Actions:** What have you done so far?

Evacuation: \_\_\_\_\_

Accountability: \_\_\_\_\_

Emergency Shutdown: \_\_\_\_\_

Access Control: \_\_\_\_\_

Notifications: \_\_\_\_\_

Other: \_\_\_\_\_

**Needs:** What do you need now?

Rescue and secure the Isolation Zone: \_\_\_\_\_

Medical and decon: \_\_\_\_\_

Emergency Shutdown: \_\_\_\_\_

Ventilation: \_\_\_\_\_

Control and Contain: \_\_\_\_\_

Downwind Receptors: \_\_\_\_\_

Other: \_\_\_\_\_

## MEDICAL TRIAGE

### CATEGORY 1. WORRIED-WELL

#### Minor Health Effects

**Limited** exposure to ammonia vapor will cause minor symptoms that are reversible. Ammonia causes irritation when it touches fluids in the eyes, nose, and mouth. Symptoms include:

- blinking, itching, and watering of eyes
- runny nose
- coughing
- skin burning sensation

#### Types of Ammonia Injuries

- Asphyxiation
- Respiratory stress
- Eye injury
- Skin chemical burn
- Freeze injury
- Ingestion

#### Associated Symptoms

- Shock, nausea
- Cardiac event

### CATEGORY 2. WALKING – WOUNDED

#### Moderate Health Effects

**Limited** exposure to **dense** ammonia vapor will cause moderate symptoms that are likely to be reversible. These symptoms must be monitored:

- severe eye irritation and tearing
- coughing
- bronchial spasm
- chest pain
- shortness of breath
- airway spasms
- increased fluid in the lungs
- severe chest pain

**First Aid** – Fresh air and/or medic-administered oxygen – “rattling” lung sounds require medical follow up; in many cases the odor and throat/nose irritation will linger 2 to 24 hours. If symptoms worsen seek medical care.

### CATEGORY 3. ACUTE HEALTH CONCERNS

**Extended** exposure to **dense** ammonia vapor is life threatening, causing:

- chemical bronchitis
- fluid accumulation in the lungs
- chemical burns of the skin
- death

**Note:** Permanent lung damage has not been associated with acute ammonia exposure except when the exposure concentrations were near lethal levels, or when chemical bronchitis develops.

Advanced medical care and medical follow up required.

See [atsdr.cdc.gov/toxprofiles](https://www.atsdr.cdc.gov/toxprofiles) for more medical information about NH<sub>3</sub>

## MEDICAL OFFICER CHECKLIST

### SIZE-UP AND CONTACTS

**Note:** (Review pp. 5–9) for Health Exposure, First Aid, and Triage checklists.

Transport to the hospital if:

- Ingested  $\text{NH}_3$
- Persistent coughing, difficulty breathing or shortness of breath, wheezing or high-pitched voice.
- Chest pain or tightness.
- Eye tissue damage, or increasing pain or discharge from the eyes.
- Increased redness, pain or puss like discharge in the area of skin burn.
- Increasing stomach pain or vomiting.
- Frost burn or skin tissue damage.

### QUICK GUIDE

- Monitor respiratory recovery of those who experienced high vapor exposure (especially those who experienced AEGL 2 or 3). Seek medical evaluation if respiratory problems develop during first 24 hours of recovery.
- Set up treatment locations for minor health concerns and separately for those needing emergency medical and possible transport.
- Monitor ABCs: Airway, Breathing, Circulation.
- Coordinate with Public Safety IC or Medical Officer for medical care and transport.
- Provide comfort and information to the “worried-well.”
- Evaluate hydration and physical well-being of facility Response Team.
- Provide SDS and advanced medical care information with transported victims.
- Ensure family notification and care while dealing with emergency care of employee.
- Utilize **[www.atsdr.cdc.gov/toxprofiles](http://www.atsdr.cdc.gov/toxprofiles)** for advanced medical care advice for ammonia injuries.





## ICS 206 MEDICAL PLAN

1. Incident Name	2. Date Prepared	3. Time Prepared AM/PM	4. Operational Period					
<b>5. Incident Medical Aid Station</b>								
Medical Aid Stations	Location	Paramedics						
		Yes	No					
<b>6. Transportation</b>								
<b>A. Ambulance Services</b>								
Name	Address	Phone	Paramedics					
			Yes	No				
<b>B. Incident Ambulances</b>								
Name	Location	Paramedics						
		Yes	No					
<b>7. Hospitals</b>								
Name	Address	Travel Time		Phone	Helipad		Burn Center	
		Air	Ground		Y	N	Y	N
<b>8. Medical Emergency Procedures</b>								
<p><b>Respiratory:</b> Coughing and bronchial spasms at 1,700 PPM; assess for lung sounds and consider O2 nasal cannula or intubation if serious respiratory challenge exists (similar to treatment of a severe asthma attack).</p> <p><b>Eye exposure:</b> Eyes begin to irritate at 700 PPM; Eye injuries—hold eye lids open and flush with water for 15 to 30 minutes.</p> <p><b>Skin Damage:</b> Ammonia creates an ALKALINE, chemical injury—<b>do not use</b> thermal or acid injury treatment protocols. Skin damage begins at 10,000 PPM direct exposure to skin; third degree skin damage—based on the time/duration/intensity of exposure—aerosol skin burns are the worst. Flush with water for 15 to 30 minutes, do not rub or use ointments; flush time based on depth of injury.</p> <p><b>Aerosol or liquid on skin or on clothing:</b> Remove ALL clothing, socks and shoes, unless frozen to skin (clothing needs to be thawed by using water flush BEFORE removal) and then flush 15 to 30 minutes</p> <p>Vapor exposure can be decontaminated with air from a fan. A five-minute water flush and then move to a more comfortable inside shower for 10 to 20 minutes of additional flushing.</p> <p><b>Ingestion:</b> Do not induce vomiting, administer water if the person is conscious.</p> <p><b>Assess:</b> Check for cardiac, shock, and heat stress related injuries; rehab, monitor vitals, and hydrate.</p>								
9. Prepared by (Medical Unit Leader)				10. Reviewed by (Safety Officer)				

## 5. Technical Information

### PRESSURE/TEMPERATURE AND RELEASE ESTIMATOR

Temp °F	Press HG/psig	Temp °F	Press psig	Temp °F	Press psig	Temp °F	Press psig	Temp °F	Press psig
-105	27.88 Hg	10	23.68	70	113.78	92	171.47	115	250.87
-70	21.78 Hg	20	33.36	72	118.37	95	180.65	117	258.81
-60	18.66 Hg	30	44.86	75	125.48	97	186.95	120	271.06
-50	14.37 Hg	40	58.41	78	132.89	100	196.70	130	314.87
-40	8.79 Hg	45	66.03	80	137.99	102	203.39	140	363.53
-30	1.17Hg	50	74.25	82	143.22	105	213.73	160	476.76
-20	3.54	55	83.10	85	151.33	107	220.82	180	613.58
-10	8.96	60	92.62	87	156.90	110	231.77	200	777.15
0	15.62	65	102.83	90	165.54	112	239.28	250	1329.20

Diameter	Temperature °F	Pressure psig	Vapor Min Flow	Liquid/Per Min Flow
1/8"	68° 95° 122°	109.3 180.7 279.5	4# Per Min. 6# Per Min. 9# Per Min.	71# Per Min. 101# Per Min. 123# Per Min.
1/2"	68° 95° 122°	109.3 180.7 279.5	25# Per Min. 38# Per Min. 56# Per Min.	481# Per Min. 651# Per Min. 792# Per Min.
3/4"	68° 95° 122°	109.3 180.7 279.5	46# Per Min. 71# Per Min. 104# Per Min.	851# Per Min. 1202# Per Min. 1463# Per Min.
1"	68° 95° 122°	109.3 180.7 279.5	77# Per Min. 118# Per Min. 104# Per Min.	1416# Per Min. 2000# Per Min. 2434# Per Min.
1 1/2"	68° 95° 122°	109.3 180.7 279.5	188# Per Min. 289# Per Min. 425# Per Min.	3478# Per Min. 4913# Per Min. 5980# Per Min.

Draft Presentation to IIAR 2016 Conference by: Professor Doug Reindl, University of Wisconsin

## ZONES CONTROL DISTANCES

### Estimating Wind Speed from Environmental Clues

mph	Km/h	Wind Description	Specifications
<6	<10	Low wind	Wind felt on face; leaves rustle; ordinary vane moved by wind
6-12	10-20	Moderate wind	Raises dust, loose paper; small branches are moved
>12	>20	High wind	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty

**Table 3 - Initial Isolation and Protective Action Distances for Large Spills for Different Quantities of Six Common TIH (PH in the US Gases**

#### UN1005 Ammonia, anhydrous: Large Spills

First ISOLATE in all Directions		
	Meters	Feet
TRANSPORT CONTAINER		
Rail tank car	300	(1000)
Highway tank truck or trailer	150	(500)
Agricultural nurse tank	60	(200)
Multiple small cylinders	30	(100)

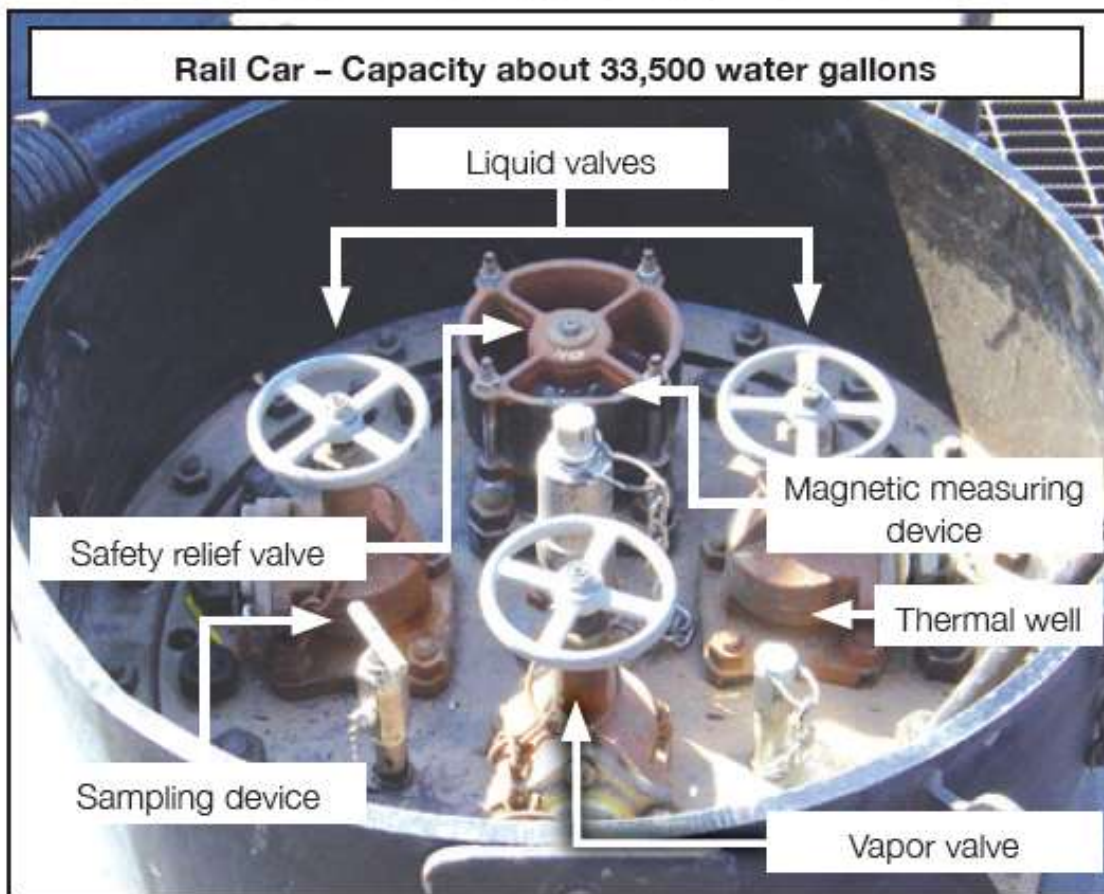
Then PROTECT persons Downwind during												
Transport Container	Day						Night					
	Low wind ( $<6$ mph - $<10$ km/h)		Moderate wind (6-12 mph - 10-20 km/h)		High wind ( $>12$ mph - $>20$ km/h)		Low wind ( $<6$ mph - $<10$ km/h)		Moderate wind (6-12 mph - 10-20 km/h)		High wind ( $>12$ mph - $>20$ km/h)	
	km	(miles)	km	(miles)	km	(miles)	km	(miles)	km	(miles)	km	(miles)
Rail tank car	1.7	(1.1)	1.3	(0.8)	1.0	(0.6)	4.3	(2.7)	2.3	(1.4)	1.3	(0.8)
Highway tank truck or trailer	0.9	(0.6)	0.5	(0.3)	0.4	(0.3)	2.0	(1.3)	0.8	(0.5)	0.6	(0.4)
Agricultural nurse tank	0.5	(0.3)	0.3	(0.2)	0.3	(0.2)	1.3	(0.8)	0.3	(0.2)	0.3	(0.2)
Multiple small cylinders	0.3	(0.2)	0.2	(0.1)	0.1	(0.1)	0.7	(0.5)	0.3	(0.2)	0.2	(0.1)

Information provided by the 2016 Emergency Response Guidebook, U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration.

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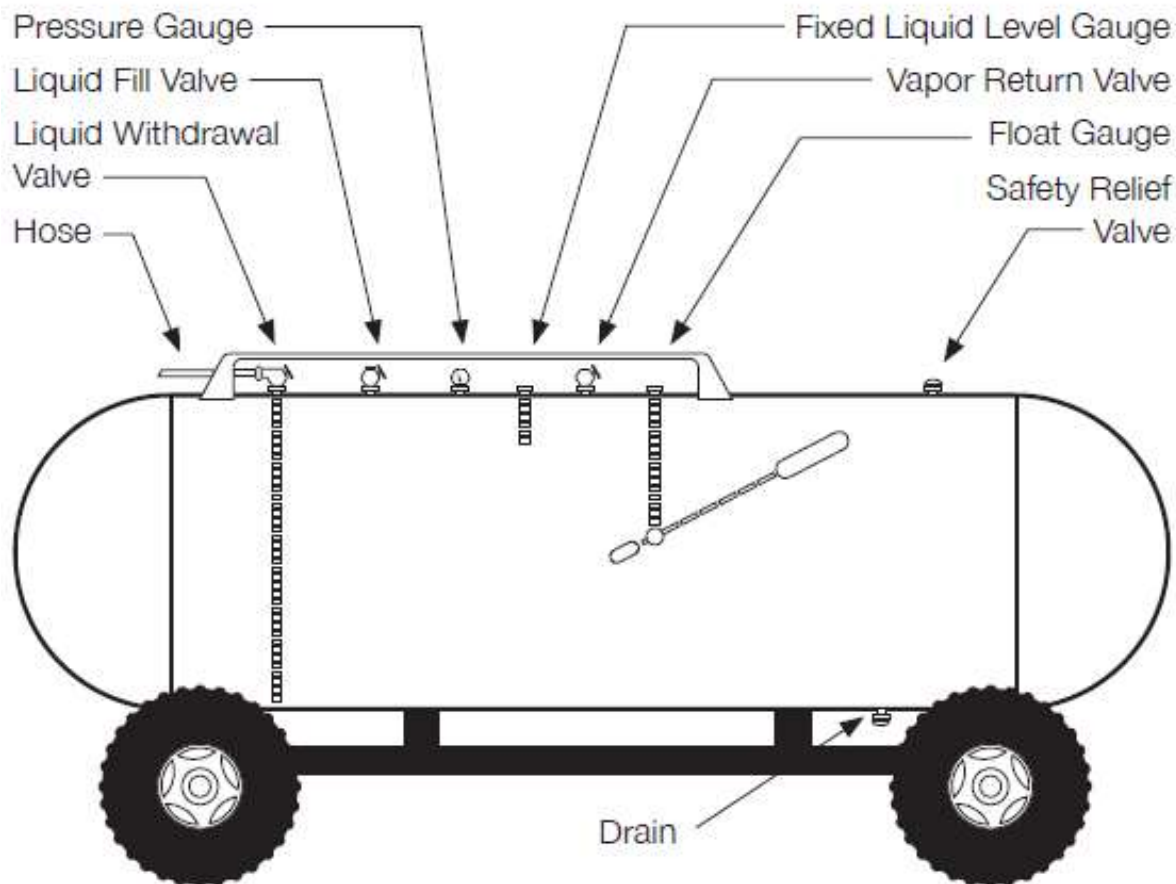
## AMMONIA TRANSPORTATION

### Railcar Protective Housing and Bobtail Delivery Truck





## NURSE TANK



**Anhydrous Ammonia Nurse Tank**

S.N./NAT'L BD. NO. <span style="border: 1px solid black; display: inline-block; width: 150px; height: 20px;"></span>			
<b>CERTIFIED BY</b> <b>TRINITY INDUSTRIES, INC.</b> DALLAS, TX			
MAWP: 250 PSIG. @ 125°F MDMT: -20°F @ 250 PSIG			
<div style="border: 1px solid black; width: 100px; height: 20px; margin: 0 auto;"></div> PLANT		<div style="border: 1px solid black; width: 100px; height: 20px; margin: 0 auto;"></div> YEAR BUILT	
ANSI K61.1-1999			
W RT 4 PHT	HEMI	1,000	8,328
40.96"	0.239"	0.203"	190.81"
O.S. DIA.	SHELL THK	HEAD THK	LENGTH
AG	NURSE TANK		173
TYPE			O.S.S.A. S.F.
<b>CAUTION:</b> THIS CONTAINER IS DESIGNED FOR ANHYDROUS AMMONIA USE ONLY AND MUST BE EQUIPPED WITH VALVES, FITTINGS, OR HOSES DESIGNED FOR ANHYDROUS AMMONIA USE.			

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